10/583973
AP3 Rec'd PCT/PTO 22 JUN 2006

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Device and Method for Preventing Roll in a Vehicle

The invention relates to a device and a method for preventing roll in a vehicle, comprising a detection device which determines an actual value of a yaw rate variable describing the yaw rate of the vehicle, an evaluation unit which determines a setpoint value of the yaw rate variable and a threshold value of the yaw rate variable that is suitable for limiting the setpoint value for avoiding rollover of the vehicle, and a control device for controlling vehicle units provided for influencing the longitudinal and/or transversal dynamics of the vehicle. The evaluation unit controls the vehicle units, based on a comparison between the determined actual value of the yaw rate variable and the determined setpoint value of the yaw rate variable, in such a way that the determined actual value of the yaw rate variable assumes the determined setpoint value of the yaw rate variable. In the event that the setpoint value of the yaw rate variable exceeds the threshold value of the yaw rate variable, to avoid rollover of the vehicle the evaluation unit limits the determined setpoint value of the yaw rate variable to the determined threshold value of the yaw rate variable.

Such a stabilization system for increasing the roll stability of a vehicle proceeds from DE 198 30 189 A1. The vehicle has a device for regulating the yaw moment which in a known manner regulates the yaw rate of the vehicle to a setpoint value, which depends on the driver's specifications, by intervening in the braking means and/or drive means of the vehicle, and the threshold value for avoiding rollover of the vehicle is limited to a physically meaningful value. The physical considerations take into account not only

the coefficient of friction conditions of the roadway surface, but also the critical transverse acceleration which when reached causes the vehicle to roll.

The object of the device according to the invention or the method according to the invention is to provide an alternative stabilization system for increasing the roll stability of a vehicle, which allows a reliable and direct assessment of the instantaneous roll state of the vehicle.

The device according to the invention for preventing roll in a vehicle comprises a detection device which determines an actual value of a yaw rate variable describing the yaw rate of the vehicle, and an evaluation unit which determines a setpoint value of the yaw rate variable and a threshold value of the yaw rate variable that is suitable for limiting the setpoint value for avoiding rollover of the vehicle. There is also a control device for controlling vehicle units provided for influencing the longitudinal and/or transversal dynamics of the vehicle. The evaluation unit controls the vehicle units, based on a comparison between the determined actual value of the yaw rate variable and the determined setpoint value of the yaw rate variable, in such a way that the determined actual value of the yaw rate variable assumes the determined setpoint value of the yaw rate variable. In the event that the setpoint value of the yaw rate variable exceeds the threshold value of the yaw rate variable, to avoid rollover of the vehicle the evaluation unit limits the determined setpoint value of the yaw rate variable to the determined threshold value of the yaw rate variable. According to the invention, the evaluation unit determines the threshold value of the yaw rate variable as a function of a threshold value of a roll angle variable which describes a roll angle of the vehicle. The values which the roll angle variable can assume in the course of travel of the vehicle span an n-dimensional ($n \in \aleph$) array which may be divided into two n-dimensional subarrays, of which a first subarray includes all values of the roll angle

variable that result in a roll-stable state of the vehicle, whereas a second subarray includes all values of the roll angle variable for which the vehicle assumes a rolling state. Thus, due to the unambiguous assignment to one of the two subarrays, the roll angle variable allows a reliable and direct assessment of the instantaneous roll state of the vehicle. Accordingly, to prevent a rollover the threshold value of the roll angle variable is selected such that it is an element of the first subarray. The values of the roll angle variable included in the two subarrays may be present either in the form of discrete single values or in the form of a continuum. The roll angle variable in particular is the tipping angle of the vehicle which describes a rotation of the vehicle about a tipping axis oriented in the longitudinal direction of the vehicle.

Advantageous embodiments of the device according to the invention are stated in the subclaims.

It is advantageous for the threshold value of the roll angle variable to be a part of the intersection formed by the two subarrays, so that the threshold value of the roll angle variable determined by the evaluation unit characterizes a defined transition between a roll-stable state and a rolling state of the vehicle. In this case, the threshold value of the yaw rate variable may be determined in such a way that the setpoint value of the yaw rate variable is limited by interventions in the vehicle units only when the instantaneous roll state of the vehicle actually makes this necessary. A significant increase in the comfort level for both the driver and passengers is thus achieved.

The evaluation unit determines the setpoint value of the yaw rate variable, for example as a function of a determined steering angle variable which describes the steering angle which can be set at the steerable wheels of the vehicle, and/or as a function of a longitudinal speed variable which

describes the longitudinal speed of the vehicle, it being possible to use a simple and, in most cases, adequate single-track vehicle model (see "Bosch, Kraftfahrtechnisches Taschenbuch" [Automotive Engineering Handbook], Vieweg-Verlag, 23rd Edition, pp. 707ff.).

For reliable detection of the instantaneous roll state of the vehicle, it is possible for the evaluation unit to determine the threshold value of the yaw rate variable as a function of variables that characterize the load state and/or geometric characteristics and/or body characteristics of the vehicle.

The load state of the vehicle may be accurately characterized in particular by indicating the position of center of gravity and/or the mass of the vehicle. Accordingly, the variables that characterize the load state of the vehicle include a position of center of gravity variable which describes the location of the center of gravity of the vehicle, and/or a mass variable which describes the mass of the vehicle.

With regard to the geometric and body characteristics of the vehicle, primarily the track width, the position of center of roll, and the roll resistance of the body of the vehicle have a significant influence on the roll behavior of the vehicle. It is therefore advantageous for the variables that characterize the geometric characteristics of the vehicle to include a track width variable which describes the track width of the vehicle, and/or a position of center of roll variable which describes the location of the center of roll of the vehicle. The same applies for the variables that characterize the body characteristics of the vehicle, which preferably include a roll resistance variable which describes the roll resistance of the vehicle.

It is advantageous for the evaluation unit to determine the position of center of gravity variable and/or the mass variable while and/or before the

vehicle starts to travel, so that in each case the values for the position of center of gravity variable and/or the mass variable, which correspond to the instantaneous load state of the vehicle, are available for determining the threshold value of the yaw rate variable.

The position of center of gravity variable and/or the mass variable may be accurately determined as a function of variables that characterize the state of motion of the vehicle, and/or as a function of the temporal response of at least one of these variables. Particularly good accuracy is achieved when the variables that characterize the state of motion of the vehicle include a tipping angle variable which describes the tipping angle of the vehicle, and/or a pitch angle variable which describes the pitch angle of the vehicle. The tipping angle variable and/or the pitch angle is determined, for example, by evaluating the deflection paths which occur at the wheel suspension units of the vehicle, or by use of appropriate angle sensors.

To reduce the computing demands placed on the evaluation unit, as an alternative to the previously described determination of the position of center of gravity variable and/or mass variable it is possible in each case to store a fixed, predetermined value for the position of center of gravity variable and/or the mass variable in the evaluation unit. The values stored in the evaluation unit are specified in such a manner that even unfavorable load states of the vehicle are taken into account which cannot result in a rollover of the vehicle ("worst case").

Furthermore, for reliable determination of the instantaneous roll state of the vehicle the evaluation unit can determine the threshold value of the yaw rate variable as a function of variables that characterize the transverse dynamics of the vehicle. In this regard the transverse acceleration acting on the vehicle is of particular importance, so that it is advantageous for the

variables that describe the transverse dynamics of the vehicle to include a transverse dynamics variable which describes the transverse acceleration acting on the vehicle.

It is possible to achieve an exact and low-delay influence of the actual value of the yaw rate variable, as defined by the setpoint value of the yaw rate variable, in particular when the vehicle units are drive means for providing propulsion which acts on the vehicle, and/or braking means for braking the wheels of the vehicle, and/or steering means for influencing the steering of the vehicle. The drive means includes, among other components, the engine, transmission, and transmission coupling for the vehicle, whereas the braking means includes wheel braking devices associated with the wheels of the vehicle. The braking means preferably is designed so that the wheels of the vehicle may each be braked independently, thereby enabling the actual value of the yaw rate variable to be influenced in a particularly accurate manner. The steering means is provided in a known manner for influencing the steering angle which can be set at the steerable wheels of the vehicle. Intervention in the steering means of the vehicle allows the actual value of the yaw rate variable to be influenced in a particularly low-delay and thus convenience-prioritized manner. The braking means and/or the drive means and/or the steering means may be controlled by the evaluation unit via a control device for performing interventions independently of the driver.

The detection device, evaluation unit, and control device are advantageously components of an electronic stability program (ESP) system, so that in particular the stability system according to the invention may be converted or retrofitted economically and relatively easily by modifying a conventional ESP system, i.e., one that is already present in the vehicle.

To indicate to the driver the presence of a critical roll state of the vehicle, the evaluation unit provides controllable driver information means for sending optical and/or acoustic driver information, and the evaluation unit causes the optical and/or acoustic driver information to be sent in conjunction with the control of the vehicle units.

The device according to the invention and the method according to the invention are explained in greater detail below, with reference to the appended drawings which show the following:

Figure 1 shows a schematically illustrated exemplary embodiment of the device according to the invention; and

Figure 2 shows an exemplary embodiment of the method according to the invention in the form of a flow diagram.

Figure 1 shows a schematically illustrated exemplary embodiment of the device according to the invention for preventing roll in a vehicle. The device comprises a detection device 10 which determines an actual value $\dot{\psi}_{actual}$ of a yaw rate variable describing the yaw rate of the vehicle, and an evaluation unit 11 which determines a setpoint value $\dot{\psi}_{setpoint}$ of the yaw rate variable and a threshold value $\dot{\psi}_{threshold}$ of the yaw rate variable that is suitable for limiting the setpoint value $\dot{\psi}_{setpoint}$ for avoiding rollover of the vehicle. The detection device 10 is, for example, a yaw rate sensor situated in the vehicle which is operatively linked to the evaluation unit 11. There is also a control device 12, operatively linked to the evaluation unit 11, for controlling, independently of the driver, vehicle units 13 provided for influencing the longitudinal and/or transversal dynamics of the vehicle. The detection device 10, evaluation unit 11, and control device 12 are

components of an electronic stability program (ESP) system present in the vehicle.

The vehicle units 13 are drive means 13a for providing propulsion which acts on the vehicle, and/or braking means 13b for braking the wheels of the vehicle, and/or steering means 13c for influencing the steering of the vehicle. The drive means 13a includes, among other components, the engine, transmission, and transmission coupling for the vehicle, whereas the braking means 13b includes wheel braking devices associated with the wheels of the vehicle. The braking means 13b is designed so that the wheels of the vehicle may each be braked independently. The steering means 13c is provided in a known manner for influencing a steering angle which can be set at the steerable wheels of the vehicle.

The evaluation unit 11 controls the vehicle units 13, based on a comparison between the determined actual value $\dot{\psi}_{actual}$ of the yaw rate variable and the determined setpoint value $\dot{\psi}_{setpoint}$ of the yaw rate variable, in such a way that the determined actual value $\dot{\psi}_{actual}$ of the yaw rate variable assumes the determined setpoint value $\dot{\psi}_{setpoint}$ of the yaw rate variable. In the event that the setpoint value $\dot{\psi}_{setpoint}$ of the yaw rate variable exceeds the threshold value $\dot{\psi}_{threshold}$ of the yaw rate variable, to avoid rollover of the vehicle the evaluation unit 11 limits the determined setpoint value $\dot{\psi}_{setpoint}$ of the yaw rate variable to the determined threshold value $\dot{\psi}_{threshold}$ of the yaw rate variable.

The setpoint value $\dot{\psi}_{setpoint}$ of the yaw rate variable is determined by the evaluation unit 11 as a function of a determined steering angle variable δ which describes the steering angle which can be set at the steerable wheels of the vehicle, and/or as a function of a longitudinal speed variable v_f which

describes the longitudinal speed of the vehicle, based on a single-track vehicle model.

To determine the steering angle variable δ, a steering angle sensor 14 is provided which detects the deflection α of a steering control 15 provided in the vehicle for driver-side influence of the steering angle, and converts the deflection to a corresponding signal that is sent to the evaluation unit 11. There are also wheel speed sensors 20 which detect the rotational speeds at the wheels of the vehicle and generate corresponding signals that are sent to the evaluation unit 11 for determining the longitudinal speed variable v_f.

According to the invention, the evaluation unit 11 determines the threshold value $\dot{\psi}_{threshold}$ of the yaw rate variable as a function of a threshold value $\varphi_{threshold}$ of a roll angle variable φ which describes a roll angle of the vehicle. In the present exemplary embodiment, the roll angle variable φ is the tipping angle of the vehicle which describes a rotation of the vehicle about a tipping axis oriented in the longitudinal direction of the vehicle. Of course, instead of the tipping angle any other roll angle variable φ may be used which describes a roll angle of the vehicle.

The threshold value $\varphi_{threshold}$ of the roll angle variable φ is determined based on kinematic considerations. The evaluation unit 11 takes into account variables that characterize the load state and/or geometric characteristics and/or body characteristics of the vehicle. The load state of the vehicle is characterized, for example, by indicating the position of center of gravity and/or the mass of the vehicle. Accordingly, the variables that characterize the load state of the vehicle include a position of center of gravity variable h_{sp} which describes the location of the center of gravity of the vehicle, and/or a mass variable m_f which describes the mass of the vehicle. In the present case, the position of center of gravity variable h_{sp} should describe the height of the center of gravity of the vehicle relative to the roadway surface. With regard to with the geometric and/or body

characteristics of the vehicle, primarily the track width, the position of center of roll, and the roll resistance of the body of the vehicle have a significant influence on the roll behavior of the vehicle. The variables that characterize the geometric characteristics of the vehicle therefore include a track width variable s_f which describes the track width of the vehicle, and/or a position of center of roll variable h_w which describes the location of the center of roll of the vehicle. In the present case, the position of center of roll variable h_w should describe the height of the center of roll of the vehicle. Lastly, the variables that characterize the body characteristics of the vehicle include a roll resistance variable c_φ which describes the roll resistance of the vehicle.

The evaluation unit 11 determines the position of center of gravity variable h_{sp} and/or the mass variable m_f while and/or before the vehicle starts to travel. These variables are determined as a function of variables that characterize the state of motion of the vehicle, and/or as a function of the temporal response of at least one of these variables. The variables that characterize the state of motion of the vehicle include a tipping angle variable which describes the tipping angle of the vehicle, and/or a pitch angle variable which describes the pitch angle of the vehicle. The tipping angle variable and/or the pitch angle is determined by evaluating the deflection paths which occur at the wheel suspension units of the vehicle, which are detected by appropriate deflection path sensors 21 which are operatively linked to the evaluation unit 11. The deflection path sensors 21 are generally present in vehicles equipped with pneumatic suspension.

The track width variable s_f, position of center of roll variable h_w, and roll resistance variable c_φ are generally invariant variables which are stored as fixed values in the evaluation unit 11.

As an alternative to the described determination of the position of center of gravity variable h_{sp} and/or the mass variable m_f, the device

according to the invention is designed so that in each case a fixed, predetermined value for the position of center of gravity variable h_{sp} and/or the mass variable m_f is stored in the evaluation unit 11. The values stored in the evaluation unit 11 are specified in such a manner that even unfavorable load states are taken into account which cannot result in a rollover of the vehicle ("worst case").

In the determination of the yaw rate variable, the evaluation unit 11 additionally or alternatively takes variables into account which characterize the transverse dynamics of the vehicle and which include a transverse acceleration variable a_q which describes the transverse acceleration acting on the vehicle. The transverse acceleration variable a_q is determined by means of a transverse acceleration sensor 22 provided in the vehicle, the signals from which are sent to the evaluation unit 11.

In the case of a roll-stable state, in which all wheels of the vehicle are in contact with the roadway surface, with consideration of conservation of angular momentum a differential equation is obtained:

$$\theta_{xx} \cdot \ddot{\varphi} = m_f \cdot (h_{sp} - h_w)\ (a_q + g \cdot \phi) - c_\phi \cdot \phi - d_\phi \cdot \phi\ , \qquad (1.1)$$

where:

- φ – roll angle variable (tipping angle)
- θ_{xx} – principal moment of inertia of the vehicle about the roll axis (tipping axis)
- m_f – mass variable
- h_{sp} – position of center of gravity variable
- h_w – position of center of roll variable
- a_q – transverse acceleration variable
- g – acceleration of gravity variable
- c_φ – roll resistance variable
- d_φ – roll damping variable

The roll damping variable d_φ describes the roll damping of the vehicle, which results from the damping characteristics of the wheel suspension units.

Assuming that in the case of a roll-stable state of the vehicle the roll angle variable φ takes on stationary values, $\ddot{\varphi} = \dot{\varphi} = 0$, it follows from equation (1.1):

$$\varphi = \frac{a_q}{g} \cdot \varphi_o, \tag{1.2}$$

where

$$\varphi_o := \frac{1}{k_\varphi - 1} \tag{1.3}$$

and

$$k_\varphi := \frac{c_\varphi}{m_f \cdot g \cdot (h_{sp} - h_w)} \quad . \tag{1.4}$$

On the other hand, in the case of a rolling state, in which at least one of the inside cornering wheels of the vehicle no longer makes contact with the roadway surface, a differential equation is obtained, as follows:

$$\theta_{xx} \cdot \ddot{\varphi} = -m_f \cdot g \cdot (\frac{s_f}{2} \cdot \cos\varphi - h_{sp} \cdot \sin\varphi) \tag{2.1}$$

$$+m_f \cdot a_q \cdot (h_{sp} \cdot \cos\phi - \frac{s_f}{2} \cdot \sin\phi),$$

where:

s_f – track width variable

Assuming that in the case of a rolling state of the vehicle the roll angle variable φ and its change over time, i.e., time derivative $\dot{\varphi}$, takes on stationary values, $\ddot{\varphi} = 0$, it follows from equation (2.1):

$$\phi = \arctan\left(\frac{\frac{s_r}{2h_{sp}} - \frac{a_q}{g}}{1 + \frac{s_f}{2h_{sp}}\frac{a_q}{g}}\right). \tag{2.2}$$

For small values of the roll angle variable φ, series expansion of equation (2.2) results in the following:

$$\varphi \approx \frac{\frac{s_f}{2h_{sp}} - \frac{a_q}{g}}{1 + \frac{s_f}{2h_{sp}}\frac{a_q}{g}}. \tag{2.3}$$

If equations (1.2) and (2.3) are each solved for the transverse acceleration variable a_q, then equated and finally solved for the roll angle variable φ, an equation of the form

$$\varphi_{thres} \approx -\frac{h_{sp}}{s_f}(1+\varphi_0) + \sqrt{\left(\frac{h_{sp}}{s_f}\right)^2 (1+\varphi_0)^2 + \varphi_0}\ , \tag{3.1}$$

is obtained which indicates a threshold value $\varphi_{threshold}$ of the roll angle variable φ which characterizes a defined transition between a roll-stable state and a rolling state of the vehicle.

To determine the threshold value $\dot{\psi}_{threshold}$ of the yaw rate variable according to equation (3.1), the position of center of gravity variable h_{sp}, the mass variable m_f, the track width variable s_f, the center of roll variable h_w, and the roll resistance variable c_φ, but not the transverse acceleration variable a_q, must be known:

$$\phi_{thres} \equiv \phi_{thres}\,(h_{sp}, m_f, s_f, h_w, c_\phi) \quad . \tag{3.2}$$

Accordingly, the following equation then also applies for determining the threshold value $\dot{\psi}_{threshold}$ of the yaw rate variable:

$$\psi_{thres} \equiv \psi_{thres}\,(h_{sp}, m_f, s_f, h_w, c_\phi) \quad . \tag{3.3}$$

If the position of center of gravity variable h_{sp} is unknown, there is an alternative approach for determining the threshold value $\varphi_{threshold}$ of the roll angle variable φ. For this purpose, equations (1.2) and (2.3) are equated and then solved for the transverse acceleration variable a_q:

$$a_q \approx -\frac{g \cdot h_{sp}}{\varphi_0 \cdot s_f}(1+\varphi_0) + g \cdot \sqrt{\left(\frac{h_{sp}}{\varphi_0 \cdot s_f}\right)^2 (1+\varphi_0)^2 + \frac{1}{\varphi_0}} \quad . \tag{3.4}$$

Then equations (3.1) and (3.4) are each solved for the position of center of gravity variable h_{sp}, equated to one another, and solved for the threshold value $\varphi_{threshold}$ of the roll angle variable φ:

$$\varphi_{thres} \approx \frac{1 - \dfrac{2h_w}{s_f}\dfrac{a_q}{g}}{\dfrac{2c_\varphi}{m_f \cdot g \cdot s_f} + \dfrac{2h_w}{s_f} + \dfrac{a_q}{g}} \tag{3.1'}$$

To determine the threshold value $\varphi_{threshold}$ of the roll angle variable φ according to equation (3.1'), the transverse acceleration variable a_q, mass variable m_f, track width variable s_f, position of center of roll variable h_w, and roll resistance variable c_φ, but not the position of center of gravity variable h_{sp}, must be known:

$$\phi_{thres} \equiv \phi_{thres}(a_q, m_f, s_f, h_w, c_\phi) \quad (3.2')$$

Accordingly, the following equation then also applies for determining the threshold value $\dot{\psi}_{threshold}$ of the yaw rate variable:

$$\psi_{thres} \equiv \psi_{thres}(a_q, m_f, s_f, h_w, c_\phi) \quad (3.3')$$

Graphically represented, the values of the roll angle variable φ span an n-dimensional array $\Re^n \ (n=5)$ which may be divided into two n-dimensional subarrays, of which a first subarray includes all values of the roll angle variable φ that result in a roll-stable state of the vehicle, whereas a second subarray includes all values of the roll angle variable φ in which the vehicle assumes a rolling state. The intersection of the two subarrays then represents the number of all possible solutions to equation (3.1) or (3.1').

The threshold value $\dot{\psi}_{threshold}$ of the yaw rate variable is determined either directly from the determined threshold value $\varphi_{threshold}$ of the roll angle variable φ

$$\dot{\psi}_{thres} \equiv \dot{\psi}_{thres}(\phi_{thres}) \ , \quad (3.5)$$

or by permitting a tolerance $\pm \Delta_{\varphi\ safe}$ for the threshold value $\varphi_{threshold}$ of the roll angle variable φ:

$$\dot{\psi}_{thres} \equiv \dot{\psi}_{thres}(\phi_{thres}) \pm \Delta\, \dot{\psi}_{thres}(\Delta\varphi_{thres} \qquad (3.6)$$

To indicate to the driver the presence of a critical roll situation, the evaluation unit 11 provides controllable driver information means 23 for sending optical and/or acoustic driver information.

The driver-side activation or deactivation of the device according to the invention is performed by use of a switch 24 provided in the vehicle.

Figure 2 shows an exemplary embodiment of the method according to the invention in the form of a flow diagram. The method is started in an initialization step 40, whereupon in a first main step 41 the actual value $\dot{\psi}_{actual}$ of the yaw rate variable is determined. In parallel in a second main step 42 the steering angle variable δ and/or the longitudinal speed variable v_f is determined, so that later in a third main step 43 the setpoint value $\dot{\psi}_{setpoint}$ of the yaw rate variable is determined based on the single-track vehicle model, as a function of the steering angle variable δ and/or the longitudinal speed variable v_f. Furthermore, in parallel in a fourth main step 44 the position of center of gravity variable h_{sp} and/or mass variable m_f and/or transverse acceleration variable a_q and/or track width variable s_f and/or position of center of roll variable h_w and/or roll resistance variable c_φ are determined or provided, so that in a subsequent fifth main step 45 the threshold value $\varphi_{threshold}$ of the roll angle variable φ, and as a function thereof, once again the setpoint value $\dot{\psi}_{setpoint}$ of the yaw rate variable, are determined.

In a sixth main step 46 the actual value $\dot{\psi}_{actual}$ of the yaw rate variable determined in main step 41 is compared to the setpoint value $\dot{\psi}_{setpoint}$ of the yaw rate variable determined in the third main step 43, and a check is made as to whether the absolute value of the difference of the setpoint value

$\dot{\psi}_{setpoint}$ of the yaw rate variable and the actual value $\dot{\psi}_{actual}$ of the yaw rate variable exceeds a predetermined threshold value $\Delta\dot{\psi}_{ref}$:

$$|\dot{\psi}_{setpoint} - \dot{\psi}_{actual}| > \Delta\dot{\psi}_{ref} \quad . \tag{4.1}$$

If the condition specified by equation (4.1) is not satisfied, the method returns to main steps 41, 42, and 44 to begin anew with the determination of the actual value $\dot{\psi}_{actual}$ of the yaw rate variable, the setpoint value $\dot{\psi}_{setpoint}$ of the yaw rate variable, and the threshold value $\dot{\psi}_{threshold}$ of the yaw rate variable. Otherwise, the method is continued with a seventh main step 47, in which a further check is made as to whether the absolute value of the setpoint value $\dot{\psi}_{setpoint}$ of the yaw rate variable determined in the third main step 43 is less than or equal to the threshold value $\dot{\psi}_{threshold}$ of the yaw rate variable determined in the fifth main step 45:

$$|\dot{\psi}_{setpoint}| \le \dot{\psi}_{thres} \quad . \tag{4.2}$$

If the condition specified by equation (4.2) is satisfied, in a subsequent ninth main step 49 the vehicle units 13 are controlled so that the actual value $\dot{\psi}_{actual}$ of the yaw rate variable determined in the first main step 41 assumes the setpoint value $\dot{\psi}_{setpoint}$ of the yaw rate variable determined in the third main step 43. The method is then ended in a final step 50.

On the other hand, if it is determined in the seventh main step 47 that the absolute value of the setpoint value $\dot{\psi}_{setpoint}$ of the yaw rate variable determined in the third main step 43 exceeds the threshold value $\dot{\psi}_{threshold}$ of the yaw rate variable determined in the fifth main step 45, in an eighth main

step 48 the absolute value of the setpoint value $\dot{\psi}_{setpoint}$ of the yaw rate variable determined in the third main step 43 is limited to the threshold value $\dot{\psi}_{threshold}$ of the yaw rate variable determined in the fifth main step 45, whereupon in the ninth main step 49 the vehicle units 13 are controlled so that the actual value $\dot{\psi}_{actual}$ of the yaw rate variable assumes the limited setpoint value $\dot{\psi}_{setpoint}$ of the yaw rate variable. The method is then ended, likewise in the final step 50.